a 'most welcome addition,' to the stratigraphy of the Taconic range, of two plates of stratigraphical sections' by Professor Hall, 'prepared by him forty to forty-five years since.'

Those two plates, or rather five plates, for that is their exact number, were freely distributed by Professor Hall as far back as Lyell's second visit to America, 1845–46, and are well known on both sides of the Atlantic.

Professor Emmons refers to them in one of his letters, dated Raleigh, N.C., Dec. 28, 1860, of which I published an extract in 'The Taconic system and its position in stratigraphic geology' (*Proc. Amer. acad. arts and sciences*, vol. xii. p. 128, Cambridge, 1885), as follows: "You are aware that [Professor] Hall prepared five long sheets of sections illustrating his views, and which extended from the Helderberg to the Connecticut River, and from the Lake Champlain to the Connecticut valley. . . . They were designed to sustain his peculiar views. I have copies, and I wish you had them. They are curiosities in their way."

It is evident that the views entertained by Professor Hall, contesting the conclusions of Dr. Emmons, have been placed before geologists in the United States, Canada, and Europe since the appearance of 'The Taconic system' in 1842.

JULES MARCOU.

Cambridge, Mass., April 23.

A carnivorous butterfly larva.

One of the most interesting of our butterflies is that known as Fenesica tarquinius, — a unique lycinid having the wings above brown-black in color, with conspicuous orange markings both on primaries and secondaries. It has a wide geographical range, occurring very generally over North America, as also in Asia.

Donovan, in his 'Insects of India' (pl. xliv. fig. 1), illustrates the butterfly rather poorly, but says nothing about the larva; Boisduval and LeConte (*Hist. des lep. et des chen. de l'Amer. Sept.*, p. 128, pl. 37) figure the larva, pupa, and imago under the name of Polyommatus crataegi, and simply quote Abbot as stating that the larva lives in several species of Crataegus; Scudder (*Proc. Essex inst.*, iii. p. 163, 1862) treats of it under the name of Polyommatus porsenna (*Syn. list of Amer. rurales*, Bull. Buff. soc. nat. hist., iii. p. 129, May, 1876), giving the food-plants of the larva as Alnus, Ribesia, Vaccinium, and Viburnum (later, in the *American naturalist* for August, 1869, he gives the food-plants as follows, — 'probably arrow-wood, elder, and hawthorn'); Grote (*Trans. Amer. ent. soc.*, ii. p. 307) first proposed the generic name of Fenesica, but says nothing about its larval history; Strecker (*Butt. and moths*, etc. — Diurnes, p. 103) repeats simply from Scudder; while William H. Edwards, in his admirable life-histories of butterflies, has not, so far, treated of this particular species. In short, so far as the published records go, it has been generally assumed that the larva feeds upon the plants named.

The object of this brief communication is to show that in this larva we have one that is truly carnivorous,—a fact which is extremely interesting, because, so far as I can find, there is not another recorded carnivorous butterfly larva; and Mr. Scudder, who has given great attention to the butterflies, writes me in a recent letter, in reply to an inquiry on this point, that he cannot recall any mention of such. Quite a number of heterocerous larvae are known to be carnivorous by exception, and not a few are so as a rule. These are chiefly found among pyralids; and it is not necessary, for my present purpose, to refer to the cases in detail.

For some years, now, I have been studying the remarkable life-habits of the Aphididae, and especially of some of the gall-making and leaf-curling species of Pemphiginae.

In collecting material and making observations, I have been assisted by Mr. Th. Pergande, who has, on a number of occasions since 1880, found the larva of this Fenesica associated with various plant-lice. Among the species with which it has been thus found associated are Pemphigus fraxinifolii Riley, which curls the leaves of Fraxinus; Schizoneura tessellata Fitch, which crowds upon the branches of Alnus; and Pemphigus imbricator Fitch, which congregates in large masses on Fagus. All these species produce much flocculent and saccharine matter.

The frequency with which this larva was found among these plant-lice justified the suspicion that it feeds upon them or derives benefit from them; yet up to 1885 the presumption was that it benefited from the secretions of the plant-lice rather than from the insects themselves. Last fall, however, Mr. Pergande obtained abundant evidence that the Fenesica larva actually feeds upon the aphidids, and I thought it worth while to call attention to this positive proof of the carnivorous habits of the species. That the different species of plant-lice are the normal food of this larva, is rendered more than probable for the following reasons: —

1. Attempts to feed the larva upon the leaves upon which it was found have proved futile, the larva perishing rather than feed upon them.

2. The food-plants given by the authorities are such as are well known to harbor plant-lice.

3. Mr. Scudder's authorities, as he informs me, were picked up here and there; and one of them for alder, which he recalls, 'found it more commonly on a limb among plant-lice.'

4. Mr. Otto Lugger has frequently observed the larva around Baltimore among Pemphigus imbricator on beech, but never disassociated from the lice; and Judge Lawrence Johnson also found it in connection with the same species around Shreveport, La., last fall, and surmised that it might feed upon the Pemphigus; but neither of these observers were able to get positive proof of the fact.

C. V. RILEY.

Combined aerial and aquatic respiration.

In investigating combined aerial and aquatic respiration in vertebrates, the following questions have presented themselves for solution, — questions which, so far as we have been able to ascertain, have not been previously answered by physiologists: —

1. Is the aerial part of the respiration like that of animals with an exclusively aerial respiration?

2. Is the aquatic part of the respiration like that of animals with an exclusively aquatic respiration?

In answer to these questions, we offer the following facts and conclusion: —

1. Observations upon the aquatic respiration of soft-shelled turtles (*Science*, vi. p. 255; and *Amer. nat.*, 1886, p. 233) showed that the air taken from the lungs of a turtle that had been immersed several hours, had been almost completely deprived of its

oxygen, while but a trace of carbon dioxide had been added to it. The water in which it had been immersed had received, however, a much greater amount of carbon dioxide than could have been formed from the free oxygen taken from the water.

2. Tadpoles were placed in a jar partly filled with water, and the jar hermetically closed. After several hours, the air was analyzed, and the free gases in the water determined. These determinations showed that nine tenths of the oxygen consumed came from the air, and one tenth from the water; while, of the carbon dioxide produced during the experiment, the air contained three tenths, and the water seven tenths.

In order that the carbon dioxide given off by the tadpoles to the air might not be absorbed by the water during the experiment, a layer of olive-oil six millimetres thick was put upon the water.

3. It was found by careful and repeated observations, under perfectly natural conditions, that frogs in cold weather (so-called 'winter frogs'), in water at 0° to 15° C., remain with their heads above the surface from one-tenth to one-half the time, and while above the surface carry on from eight to twenty lung respirations per minute; showing, that, under natural conditions, the respiration of 'winter frogs' is not entirely or almost entirely carried on aquatically by the skin, as is commonly supposed (Klug and Martin).

4. The results obtained by Moreau and others, upon the respiratory function of the air-bladder of ordinary fishes, and those of Wilder, on the respiration of Amia (the mud-fish), are in general accord with the facts stated for turtles and tadpoles.

These facts seem to us to justify the conclusion that the respiratory gas-interchange in combined aerial and aquatic respiration does not conform to the law governing either exclusively aerial or exclusively aquatic respiration, but that, whenever aerial and aquatic respirations are combined in an animal, the aerial part of the respiration is principally to supply oxygen, and the aquatic part to get rid of carbon dioxide. S. H. and S. P. GAGE.

Anat. lab., Cornell univ., April 15.

Pharyngeal respiratory movements of adult amphibia under water.

In studying adult amphibia for possible respiratory movements under water, we have found that the common newt (Diemictylus viridescens) so abundant in lakes and ponds, and which is known to remain voluntarily a long time under water, carries on, while under water, rhythmical pharyngeal movements almost precisely like those of the soft-shelled turtles; and, as in the turtles, these movements cause a flow of water into and out of the mouth and pharynx.

The Cryptobranchus (Menopoma) has also been found to draw water into the mouth, and to expel it, in part at least, through the persistent gill-fissures.

So far as we know, these facts have not been published before. We would be glad to know if these observations have been previously made on Diemictylus and Cryptobranchus, and if similar pharyngeal movements under water have been described for other adult amphibia. S. H. and S. P. GAGE.

Anat. lab., Cornell univ., April 25.

The germination of pond-lily seeds.

In the issue of *Science*, March 21, 1884, there appeared a conditional offer of seeds of the Nymphea odorata, obtained by me in the fall of 1883, the growth of that year. Many of the seeds at this time were germinating; some had developed the second leaf. There was a marked difference in color; the variations were, in shades of red, from blood-red to light pink, from dark blue-green to light yellow-green, and from a dark bronze to a light salmon. It seemed to me, with varying and suitable culture, new varieties might be obtained, as the seeds are not always to be had, and the method of germination is not a matter of every-day observation. A number of applications were received, but I have not heard from any one, of successful culture, nor whether all or any of the seeds germinated. A succession of germinations gave me new plants to take the place of those destroyed by Unios, ferments, or fungi. The seed were kept under water, on sand, exposed to a north light, or that reflected from the brick houses on the north side of the street, fifty feet distant.

In June, 1855, I removed from the water all light seed, and those that were softened, as well as all on which fungoid growths had appeared, and placed the vessel in an open space where it had vertical light, and from the sun, for an hour between eleven and twelve in the morning in clear weather. A half-dozen new plants appeared in August, as the result of the change. When the cold weather came in the fall, I restored them to their old position in the north light, slightly obscured by ferns, Zygodium scandens and Pteris serrulata. About last Christmas I observed a new plant that had germinated since being brought in in the fall. This plant was removed to some submerged soil in another vessel, where it is now putting forth its fourth leaf. In February another seed germinated; and, since the 20th of March, three others have begun to grow. The last one was observed on the 3d of April. There are a few more very heavy seed in the water. The first plants from these seed that germinated early in 1884 — beginning in January — were peculiar in the length of the internodes, all being very long, some over an inch; and the seeds, before germination, were very light, and quite variable in color, but not as much so as the foliage.

The germinations of 1885 have shorter internodes, smaller leaves, of an even green color, whilst other germinations of this year have the internode reduced to a minimum; the leaves seem to start from the very dense and dark seed; and the foliage is variable in size and color, but mostly in light shades of bronze — salmon — with shades of pink.

The seeds varied in their development when taken from the pond in which they grew.

Some of the plants had just begun to coil the flower-stem by which to draw the seed down to the bottom of the pond; one had finished coiling, and the seed-vessel was in the mud; others were midway between these extremes. I mention this to show that there were natural and well-known causes for the variance in time of germination.

When it is known that the ripe and fully matured seeds are very dense, it will not seem so strange, that, considering the great number of seeds to a single flower, all ponds are not overcrowded, as by their density they sink into the ooze and remain dormant.